

# SCIENCE FOR GLASS PRODUCTION

UDC 666.1:658.56

## PROCESS-ORIENTED APPROACH AND STATISTICAL METHODS IN THE MANAGEMENT OF TRIPLEX GLASS QUALITY

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Translated from Steklo i Keramika, No. 8, pp. 3–5, August, 2004.

A process model of triplex glass production is constructed. The effect of using statistical management methods to improve the quality of triplex is demonstrated.

Competition in the market economy obliges the management of glass factories to give more attention to quality problems. A direct correlation exists between quality and production efficiency. An improved quality raises the production efficiency, which leads to decreasing the production cost and increasing the market share.

The Borskii Glass Works JSC has accumulated positive experience in satisfying the demands of consumers in Russia and the CIS countries and ensuring the high quality of automobile glass. The companies have homologation certificates for all types of automobile glass meeting European and American safety standards: for laminated triplex windshield and side and back hardened glasses, approval of the U.S. and Canada standard ANS 26.1.1983, approval of Regulations No. 43/R for Western Europe, and approval in the EU countries according to directive 92/22 EU [1].

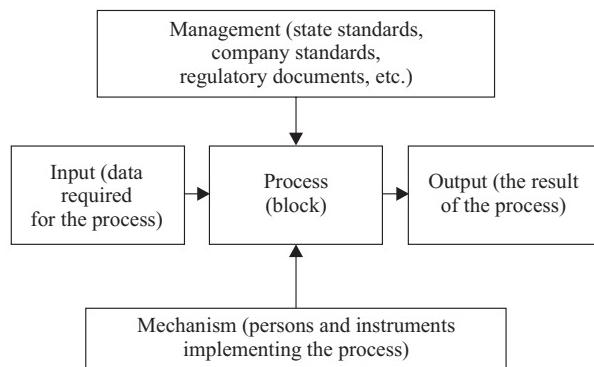
According to the contemporary theory of quality management, quality management activities cannot be effective after the product has been made. These activities should be implemented in the course of production. Activities ensuring the product quality prior to its production are essential as well. Quality is influenced by numerous random, local, and subjective factors. To minimize the effect of these factors on product quality, it is necessary to have a quality management system that constantly controls the product manufacture process to maintain the respective quality level.

The modern technology for the production of bent triplex glass is a conveyor production consisting of consecutive technological operations (processes) [2]: cutting out intermediate glass panes, removing flash, blunting glass edges, washing and drying, spray-deposition of interspersing mate-

rial, assembly and bending of laminated glass, washing and drying of bent pieces, cutting PVB film, stacking multilayer glass packets, their heating, additional pressing, and pressing of finished triplex product.

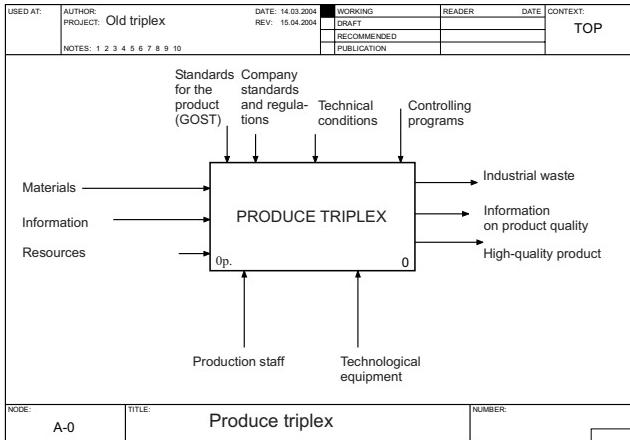
The processes in production can be adequately represented in modeling, i.e., methodology, program description, and analysis of the processes, which makes it possible to represent all of them as a set of diagrams reflecting the processes and correlating their material and information flows and the required resources.

The concept of the process-oriented approach in ISO 9000:2000 is formulated as follows “A systematic identification and management of the processes implemented in an organization and, primarily, ensuring their interaction can be regarded as the process approach.” The term “identification” in the context of the process approach is regarded as the development of a process model and using it to identify optimum parameters. The identification of optimum process pa-



**Fig. 1.** The site of connection of arcs with the block.

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**Fig. 2.** Context diagram of the model of triplex production process.

rameters is a systematic problem that has to be solved continuously during the entire process [3].

For the purpose of identification, the following parameters were determined for the processes in the production of triplex glass:

- input and output process parameters;
- data indicating the course of the process: regime variables, power and material consumption, efficiency, etc.

Furthermore, the process quality criterion was set.

These problems cannot be solved without using special methods of system analysis and modeling, in other words, the methods of structural system analysis. Nearly 90 varieties of structural system analysis are currently known; however,

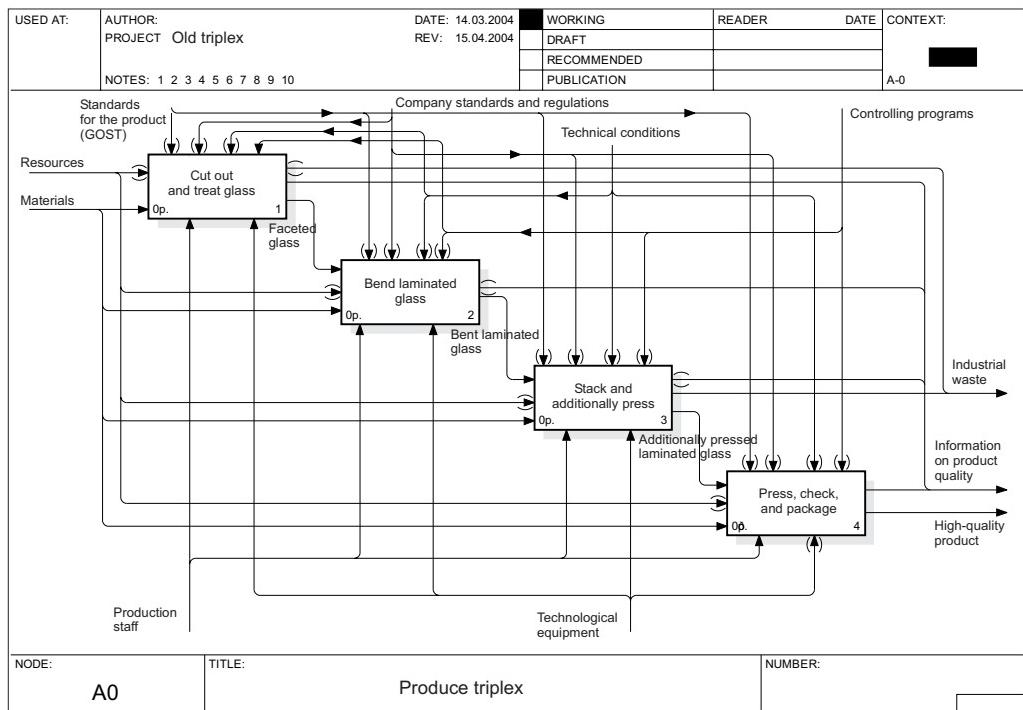
the methods most frequently used in practice are the DFD data flow diagram technology and the SADT method (its standardized subset IDEF0) [4].

To create a process model of the triplex production we have used the IDEF0 method owing to its clearness, available instruments, and simplicity [5].

According to the IDEF0 methods, the process model is described using diagrams, texts, and a glossary (Fig. 1). The diagrams define the relationships between the processes (blocks) and their executors and data. The processes transform data from the left to the right. The input and the output arrows indicate what is happening in the process at a given moment. The management (the input arrow from above) indicates the reason for it happening, and the mechanism (the input arrow from below) indicates precisely in what way it is being done.

The diagrams describing the process model were developed using the CASE automated design and modeling of information systems in the BPwin program.

An IDEF0 model is a hierarchical set of diagrams. The upper level diagram contains one block A-0 and forms the context diagram of the model of the triplex production process (Fig. 2). This block represents the technological process as a whole. Such diagram, first, is a parent diagram for the rest of the diagrams and names the general function of the system, i.e.: "Produce triplex". Second, it provides the set of the main data used in the process. For instance, based on the state standards and the company standards it is possible to manage the quality of triplex glass. Third, the diagram specifies the relations between the main types of data and delimits



**Fig. 3.** Diagram of the first level of decomposition of the model of triplex production process.

them. For instance, a certain requirement of the consumer (information) is regarded as an input datum implemented in the process, while the production staff carries out processes.

SADT models evolve in structural decomposition from top to bottom. First, the block A-0 decomposes and forms the diagram A-0 consisting of 4 blocks: cut out and treat glass; bend laminated glass; stack and additionally press; and finally, press, check, and package (numbers 1 – 4 in Fig. 3). Next, each block decomposes into other diagrams, etc., until an individual process is obtained.

The next phase after constructing the process model of triplex production is determining the traceability of the product along the entire technological chain. Each production site is analyzed regarding its effect on the quality of the triplex produced. After analyzing the process model, the problem of adjusting processes to provide stability of results was solved. Special measures were taken, such as the process quality management and the use of statistical analysis methods. The Prioritet Company (Nizhny Novgorod) has rendered great assistance in the implementation of statistical methods in the production.

The final goals of the measures taken included decreasing the number of defects, improving the speed and efficiency of correcting the triplex production process, providing an objective control, and motivating the staff engaged in the production.

The course of attaining the above-mentioned goals was based on the production plans of the factory including indexes of results, such as the percent of acceptable product,

the machinery utilization factor based on the working time, the output of the product per time unit, etc.

An important element of the system management of the triplex production based on the process approach included periodical meetings. In these meeting the results of the processes were discussed and the estimates of the product made by the customers were analyzed. Based on this results, the management made decisions on corrective or preventive measures, which were included in production plans.

The implementation of the system management based on the process approach and the use of statistical methods of control and regulation of the triplex glass production made it possible to improve the quality of the product, which brought the production losses from nearly 30% down to 6% or even lower.

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